Structural Study of Negative Parity Bands in ^{117,119}I

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1. Introduction

The most crucial characteristic of an atomic nucleus is its shape. The vast majority of deformed nuclei have prolate or oblate axially symmetric shapes. However, evidence of non-axial deformations has been seen in nuclear spectroscopy. In fact, the search for non-axial quadrupole deformation of the nucleus remains one of the most pressing problems in nuclear structural physics. Additionally, the argument over whether asymmetric atomic nuclei are γ-soft or γ-rigid has been going on for more than 50 years.

The nuclei in the mass region A$\sim$120-130 with $50 \leq z \leq 57$ has been of considerable interest as they lie in the region between primarily spherical and well-deformed nuclei. The iodine nuclei with Z = 53 exhibit the distinctive characteristics of the structure of nuclei in this area and are a crucial component for illustrating the systematics of these nuclei. Particularly noteworthy are the odd mass iodine nuclei because they exhibit nuclear structures that are greatly impacted by neutron numbers that are near to the closed shell neutron number of 82 [1]. A number of remarkable structural phenomena have been discovered in the odd-mass iodine nuclei during the past few decades as a result of γ-ray spectroscopy studies. The presence of oblate driving $\nu h_{11/2}$ and prolate driving $\pi h_{11/2}$ near Fermi surfaces tends to drive these nuclei towards triaxial forms [2].

This work is dedicated to investigate quasiparticle bands and aligned angular momentum in ^{117,119}I isotopes using the framework of Triaxial Projected Shell Model(TPSM) approach.

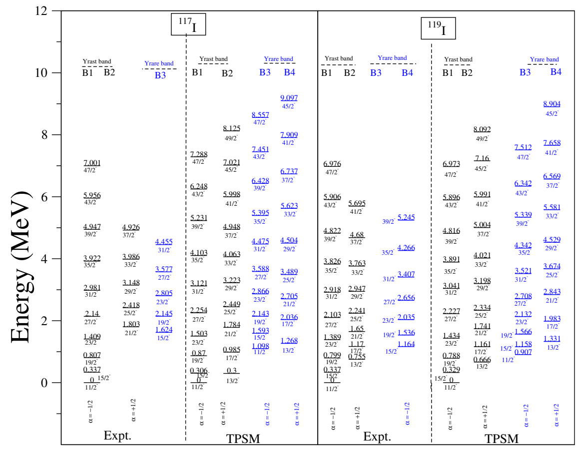

FIG. 1: The experimental data for $^{117\text{-}119}$I isotopes is presented together with the TPSM energies obtained after configuration mixing for the lowest bands. The experimental data was extracted from [3, 4].

2. Theoretical Framework

Over the years, the TPSM approach has enabled researchers to examine high-spin band structures in transitional and deformed nuclei. The TPSM technique uses a methodology identical to that of the conventional spherical shell model, with the exception that the diagonalization of the shell model Hamiltonian is done using a deformed angular momentum projected basis. The Hamiltonian is given by

$$\hat{H} = \hat{H}_0 - \frac{1}{2}\chi \sum_{\mu} \hat{Q}^{\dagger}_{\mu}\hat{Q}_{\mu} - G_M \hat{P}^{\dagger}\hat{P} - G_Q \sum_{\mu} \hat{P}^{\dagger}_{\mu}\hat{P}_{\mu}. \quad (1)$$

The terms in the equation represent the harmonic oscillator single-particle Hamiltonian, monopole pairing, quadrupole pair-

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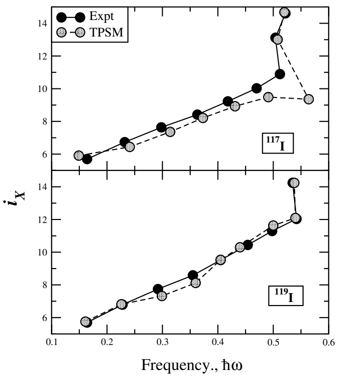

FIG. 2: Comparison of aligned angular moments, $i_x = I_x(\omega)$ - $I_{x,ref}(\omega)$ for yrast bands of ^{117,119}I.

ing and quadrupole-quadrupole interaction respectively.

TPSM calculations are performed in three stages. In the first stage, triaxial basis are generated by solving the triaxially deformed Nilsson potential with the deformation parameters of ϵ and ϵ'. The three-dimensional angular-momentum projection operator is used in the second step to project the intrinsic basis onto good angular-momentum states. The projected basis is utilised to diagonalize the Hamiltonian of the shell model in the third and last step. This Hamiltonian is then used to build the triaxially-deformed mean-field basis.

3. Results and Discussion

Several experimental groups have looked at the existence of high-spin states in odd-proton ^{117,119}I isotopes. The level schemes for both the isotopes have been extended from time to time. A comparison is made between the predicted band structures, which were derived following diagonalization of the shell model Hamiltonian, and the measured energies in Fig. 1 for ^{117}I and ^{119}I isotopes. The figure clearly demonstrates an excellent agreement between experimental and TPSM calculated values. The band structures that have been predicted will be able to offer some direction for forthcoming experimental investigations.

In the current work, another property studied for both the isotopes is aligned angular momentum (I_x). I_x has been studied experimentally for ^{117}I and ^{119}I isotopes. A backbend at $\omega = 0.51$ MeV/$\hbar$ has been witnessed for experimental alignment of the $\pi h_{11/2}$ band in ^{117}I [5]. Also, a delayed neutron $h^2_{11/2}$ alignment at about 0.53 MeV rotational frequency has been observed for yrast $h_{11/2}1/2^-$ [550] band in ^{119}I [6]. The experimental results along with TPSM counterparts are displayed in Fig. 2 and the consistency of both the results is quite evident.

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